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DRY FARMING IN SOUTHEASTERN WYOMING

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CONTENTS

	Page
Introduction	1
Soil	2
Climate	2
Experimental methods	4
Results with spring wheat	5
Results with winter wheat	6
Results with oats	8
Results with barley	10
Results with flax	11
Results with corn	12
General discussion of rotations	14
Crop resistance to drought, disease, and storm	15
Dates and rates of seeding	16
Summary	18

INTRODUCTION

Southeastern Wyoming and adjacent parts of Colorado and Nebraska constitute the district to which the results contained in this bulletin are directly applicable. The whole district has a greater altitude than most of the Great Plains area. The altitude at the Archer Field Station is 6,012 feet. The Plains continue to rise as the mountains to the west are approached until at some places the altitudes reach 7,000 feet. The altitude at the eastern boundary of Wyoming is about 5,000 feet. The contour varies from almost level or rolling to rough and broken by creeks and narrow dry ravines. The land along the creeks is usually irrigated and retained in rather large holdings. The upland is used for pasture and dry farming.

In 1912 the Wyoming State Farm Board, in cooperation with the Offices of Cereal Investigations and Dry-Land Agriculture Investigations, both of the Bureau of Plant Industry, United States Department of Agriculture, established an experiment station at Archer, which is about 8 miles east of Cheyenne. The State farm board has been discontinued, and its functions have been transferred to the University of Wyoming. The Office of Cereal Investigations discontinued its cooperation June 30, 1920. The present cooperating bodies are the University of Wyoming and the Office of Dry-Land Agriculture Investigations.

The station farm consists of 685 acres, of which 100 are in the experimental field, 68 in the general field, 10 in the farmstead, and the remainder in pastures for horses and dairy cattle. Previous to 1923 the work of the Office of Dry-Land Agriculture Investigations occupied 18 acres in the experimental field. Necessary additions to the experiments in 1923 increased the area to about 25 acres.

The land was broken in 1912, and the first crop was grown in 1913. The preparation of the land was uniform for the crop of that year, so that the results of rotation and tillage methods begin with 1914. The process of obtaining the data has proceeded in a normal manner from year to year except in 1920, when the spring work on the rotation and tillage plats was not begun until June 4. The results of this delay were decreases in yields and in the demarcation of the various methods of tillage and cropping. The yield of spring wheat on disked corn stubble in the rotation plats was 4 bushels, whereas the yield of the same variety of wheat on disked corn stubble in the varietal trials was 11.9 bushels per acre. The yields of oats, barley, and flax were affected similarly. The planting of corn was not so much delayed, and the effects were not so marked.

The data relating to dates and rates of seeding were procured from experiments conducted by the Office of Cereal Investigations and the Wyoming State Farm Board.

The natural agricultural resources of the region consist of the native grasses, which are well adapted to the production of cattle, sheep, and horses. The dry farmers who have succeeded in making comfortable homes and who continue to receive substantial incomes have made use of the native grasses and increased the carrying capacity of the range by the production of forage crops. Those who have attempted to produce small grains only have in most cases failed. A combination of these two systems will probably result in increased incomes of the dry farmers and greater stability of both ranching and dry farming.

SOIL

The soil at the Archer Field Station is a chocolate-brown sandy loam with an interspersion of a small percentage of fine gravel. The soil is 3 to 4 feet deep and is underlain by either a hardpan or gravel. The hardpan consists of the gravel cemented together and is rather impervious. The soil at the station is fairly representative of the upland in the region, but the soil along the creeks and valleys is alluvial and varies considerably from that of the upland. The soil in its native state is covered with a sod of grasses and other plants, including many legumes.

CLIMATE

The summers are rather short, cool, and pleasant, while there is little snow in the winters and heavy winds during January, February, and March. The heaviest snows generally occur during the late fall and middle spring months. The greatest precipitation is during April, May, June, and July. Fair average precipitation is received through August and September. The monthly, seasonal, and annual precipitation at the Archer Field Station from 1913 to 1923, inclusive, is given in Table 1. The monthly averages of the precipitation at Cheyenne, as recorded by the Weather Bureau for the same period of years and for the 53 years from 1871 to 1923, inclusive, are also shown in this table. The normal annual precipitation at Cheyenne for the entire period of record was 14.17 inches, and the average from 1913 to 1923, inclusive, was 15.51 inches. The average annual precipitation at the Archer Field Station for the same years was 15.01 inches.

TABLE 1.—*Monthly, seasonal, and annual precipitation at the Archer Field Station from 1913 to 1923, inclusive, compared with the averages at Cheyenne, Wyo., for the same years and for the 53-year period from 1871 to 1923, inclusive,*

[Precipitation in inches; T=trace. The averages shown at Cheyenne, Wyo., for both the 11-year and the 53-year periods are from the records of the United States Weather Bureau]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Seasonal, Apr.–Sept.	Annual
1913	0.55	0.74	0.33	1.35	2.25	1.51	2.06	2.09	2.23	0.66	0.46	1.65	11.49	15.88
1914	T	.60	.56	2.54	1.46	1.12	1.43	2.03	.32	1.29	.26	.16	8.90	11.77
1915	.08	.49	.71	4.90	1.78	1.83	1.65	2.53	1.95	1.81	.03	.56	14.64	18.32
1916	.10	.09	.19	.74	1.61	.48	1.81	4.05	1.37	.73	.88	.34	10.06	12.39
1917	.06	.80	.85	1.87	4.54	.46	1.79	1.20	.91	.57	.40	.81	10.77	14.26
1918	.47	.89	.19	4.14	1.86	2.78	2.74	1.66	2.41	1.33	.54	.58	15.59	19.59
1919	T	.14	.87	.58	.31	.59	2.76	1.19	3.10	1.48	1.26	1.10	8.53	13.38
1920	.20	.69	.34	3.88	2.08	4.33	1.21	1.25	.88	.57	.15	.27	13.63	15.85
1921	.95	.07	.14	.86	2.19	2.47	1.79	.76	.08	.21	.08	.73	8.15	10.33
1922	.32	.28	.20	2.33	2.15	2.30	1.81	2.36	.14	.06	2.23	.44	11.09	14.62
1923	.06	.42	1.06	.86	2.98	2.69	1.38	4.59	1.14	3.32	.16	.09	13.64	18.75
AVERAGES														
11 years, 1913 to 1923:														
Archer Station	.25	.47	.49	2.19	2.11	1.87	1.86	2.16	1.32	1.09	.59	.61	11.51	15.01
Cheyenne	.39	.61	.74	2.46	2.32	1.12	2.12	1.67	1.52	1.15	.68	.73	11.21	15.51
53 years, 1871 to 1923:														
Cheyenne	.39	.56	.93	1.87	2.39	1.51	2.04	1.49	1.18	.87	.47	.47	10.48	14.17

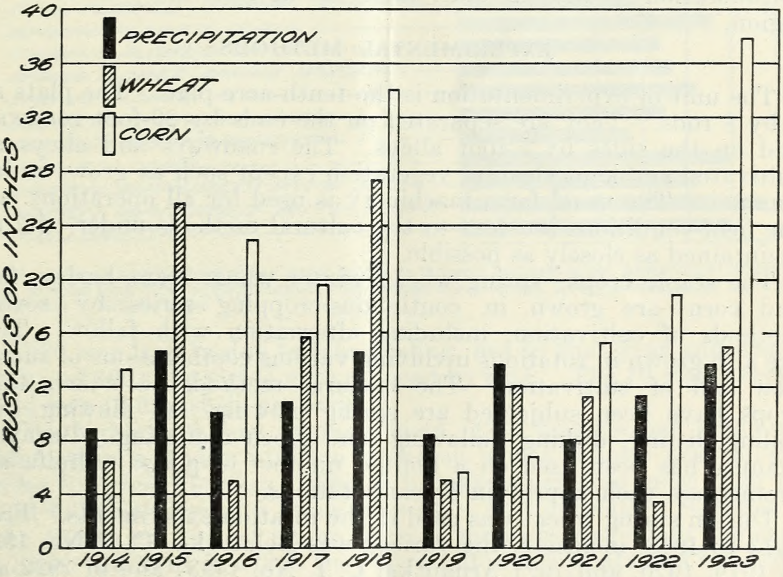

FIG. 1.—Seasonal precipitation (inches), yield of spring wheat (bushels per acre) on disked corn ground, and yield of corn (bushels per acre) on spring-plowed wheat stubble at the Archer Field Station for each of the years from 1914 to 1923, inclusive. The yield of wheat in 1920 is from the varietal tests. The other yields are from the crop-rotation experiments and are given in Tables 2 and 7

About three-fourths of the average annual precipitation occurs during the 6-months growing season from April to September, inclusive. This is a small quantity, but if distributed as best fits the needs of the growing crops it is sufficient. The feature of timeliness of the precipitation is often of greater importance than the quantity. The seasonal precipitation for each of the 10 years from 1914 to 1923, inclusive, is shown in Figure 1. The average annual yields of spring wheat and of corn, each on a standard method of preparation, are also shown in this figure. The years 1914, 1919, and 1921 each received practically the same seasonal precipitation, but differed considerably in the yields of corn and spring wheat. The annual precipitation was less in 1914 and in 1921 than in 1919. The order of yields for these three years places 1921 first, 1914 second, and 1919 third. In 1914 and 1921 the yields of corn were higher than those of wheat, but in 1919 they were nearly equal. In 1915 the corn yield was nothing and the wheat yield high, but in 1916 and in 1922 these records were reversed. The only year when both the corn and wheat yields were excessively low was 1919. During this same year the yield of Kursk millet was 2,141 pounds of forage. The only yield of millet lower than this in the nine years from 1913 to 1921, inclusive, was 1,770 pounds of hay in 1914. The 9-year average yield was 3,310 pounds of hay per acre. It is apparent from these results that different crops respond differently to the same seasonal precipitation. The factors which influence this response are: (1) The distribution of the precipitation; (2) differences in cultural methods; (3) differences in the dates of maturity of crops; and (4) differences in the resistance of crops to drought, disease, and storm. Each of these factors is of sufficient importance to require the careful consideration of anyone undertaking an agricultural pursuit in the region.

EXPERIMENTAL METHODS

The unit of experimentation is the tenth-acre plat. The plats are 2 by 8 rods. They are separated on the ends by 20-foot roadways and on the sides by 5-foot alleys. The roadways and alleys are cultivated and kept clean of vegetation except such as grows in late summer. The usual farm machinery is used for all operations, and the field conditions incident to the cultural methods under trial are maintained as closely as possible.

The staple crops—spring wheat, winter wheat, oats, barley, flax, and corn—are grown in continuous-cropping series by several methods of cultivation, including alternation with fallow. They are also grown in rotations involving various combinations of succession and of cultivation. The cultural methods to which these crops have been subjected are spring plowing, fall plowing, subsoiling, listing, disking, fallowing, and green manuring. Barnyard manure has been used on a limited number of plats. Alfalfa and bromegrass each appear in 6-year rotations.

Durum spring wheat was used in the rotation experiments. From 1913 to 1918, inclusive, the variety was Beloturka, C. I. No. 1520; in 1919, 1920, and 1921 Arnautka, C. I. No. 1493; and in 1922 and 1923, Acme, C. I. No. 5284. Turkey winter wheat was used to and including 1918. The variety of winter wheat grown in 1919, 1920, and 1921 was Kharkof, and in 1922 and 1923 it was Kanred. The oat was Swedish Select except in 1922 and 1923, when Ligowa, a variety of the same type, was grown. The variety of barley was Coast, C. I. No. 690 (California Feed), except in 1923, when a change was made to White Smyrna, C. I. No. 658. The flax was the common seed type. The variety of corn used is considered in presenting the results with that crop.

RESULTS WITH SPRING WHEAT

The spring-wheat area in Wyoming was 44,000[1] acres in 1912 and 160,000[2] acres in 1923. The increase has come about by breaking up the native prairie sod. The general method of production is to spring-plow the land once in two or three years. The crop is seeded on the plowed land and also in the stubble of the previous small-grain crop. Often the stubble is not even disked, but this is more especially true with winter wheat and winter rye than with spring wheat.

The annual and average yields of spring wheat by different methods for the 10 years from 1914 to 1923, inclusive, are given in Table 2, and the average yields are shown graphically in Figure 2. The highest average annual yields were 24.8 bushels per acre in 1915 and 23.3 bushels per acre in 1918. There has been no complete failure of spring wheat in any year, but the yields by all or most methods were very low in 5 of the 10 years. The low yield in 1920 was largely due to late seeding, but in that year and also in 1919 and 1921 the yields were reduced by rust. The 10-year average yield was 10.9 bushels per acre.

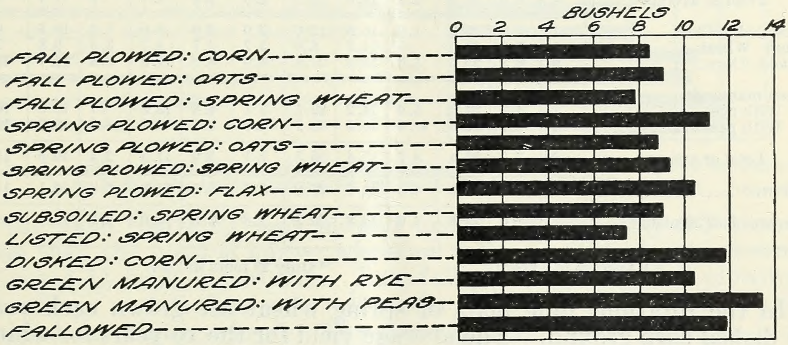

FIG. 2.—Average acre yields of spring wheat grown by different methods at the Archer Field Station for the 10 years from 1914 to 1923, inclusive. The average following flax, spring plowed, is for the 9 years from 1915 to 1923, inclusive

The highest 10-year average yield, 13.3 bushels per acre, was obtained in a 4-year rotation in which wheat follows peas plowed under for green manure. This is 3 bushels per acre more than the yield following rye as a green manure. As the relative response to peas and to rye turned under as green manures was about the same in other rotations in which they were followed by oats and by winter wheat, the possibility that the better showing of peas might be due to chance seems remote. The yield, however, is not enough greater than that on fallow to pay for the cost of seeding the green-manure crop. The average yield on nine fallowed plats was 11.8 bushels per acre, only 1.5 bushels less than the average yield following peas plowed under.

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[1] U. S. Department of Agriculture. Bureau of Statistics. Statistics of the principal crops. *In* U. S. Dept. Agr. Yearbook, 1912, p. 570. 1913.

[2] ——— Statistics of important crops by States, 1921–1923. Spring wheat. *In* Weather, Crops, and Markets, v. 4, p. 670. 1923.

TABLE 2.—*Yields of spring wheat grown by different methods at the Archer Field Station from 1914 to 1923, inclusive*

Treatment and previous crop	Plats averaged	Yields per acre (bushels)										
		1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	Average, 1914 to 1923
Fall plowed:												
Corn	1	5.7	20.3	1.3	13.2	20.7	1.7	2.3	8.3	0.3	9.8	8.4
Oats	2	4.3	24.3	2.3	13.4	20.5	.9	4.1	5.9	.9	13.5	9.0
Spring wheat	1	7.5	23.7	2.4	13.6	13.2	2.5	3.1	4.5	1.5	7.3	7.9
Total or average	4	5.5	23.1	2.1	13.4	18.7	1.5	3.4	6.2	.9	11.0	8.6
Spring plowed:												
Corn	1	9.4	26.7	.9	17.0	22.3	3.3	2.7	11.7	.9	15.3	11.0
Oats	1	4.6	23.7	1.6	11.0	22.7	1.5	3.0	9.3	.2	10.5	8.8
Spring wheat	1	6.8	26.8	2.3	15.6	18.4	3.5	1.7	6.2	1.3	10.7	9.3
Flax	1	------	26.3	4.3	12.2	25.2	2.9	2.1	10.3	1.3	9.0	[1] 10.4
Total or average	4	6.9	25.9	2.3	14.0	22.2	2.8	2.4	9.4	.9	11.4	9.8
Subsoiled: Wheat	1	5.8	25.0	1.0	16.6	12.0	2.0	2.9	3.8	7.5	13.5	9.0
Listed: Wheat	1	5.8	23.5	.8	14.3	8.8	3.2	2.7	4.7	3.8	6.8	7.4
Disked: Corn	9	6.3	25.5	5.0	15.6	27.4	4.9	4.0	11.3	3.3	14.7	11.8
Green manured:												
With rye	1	4.3	24.2	5.9	14.2	22.5	2.1	4.8	13.3	.7	10.8	10.3
With peas	1	9.7	26.5	11.4	16.5	38.1	2.0	5.2	9.2	4.0	10.2	13.3
Total or average	2	7.0	25.4	8.7	15.4	30.3	2.1	5.0	11.3	2.4	10.5	11.8
Fallowed	9	8.8	24.5	4.3	14.7	23.0	4.8	3.5	11.6	6.4	16.1	11.8
Average of all 30 plats [2]	------	7.0	24.8	4.0	14.8	23.3	3.8	3.5	10.0	3.7	13.6	10.9

[1] Average of 9 years.

[2] Only 29 plats in 1914.

In the rotations nine plats of spring wheat are grown each year on disked corn ground. The average yield for the 10 years for which results have been obtained was 11.8 bushels per acre, exactly the same as the average on fallow. Wheat on corn ground plowed in the spring averaged 11 bushels per acre and on corn ground plowed in the fall 8.4 bushels per acre.

The yields on fallow, green manures, and corn ground averaged higher as a group than those following wheat or other small grains. Within the latter group the range of yields was not great. Following oats the yield on fall plowing averaged slightly higher than on spring plowing. On the four plats cropped continuously to wheat the one plowed in the spring averaged 9.3 bushels, the one subsoiled 9 bushels, the one fall-plowed 7.9 bushels, and the one listed in the fall 7.4 bushels per acre. One plat on spring plowing following flax averaged 10.4 bushels for the nine years from 1915 to 1923, inclusive. In 1914, the year lacking in the record of this plat, the yields of all plats were somewhat below the average.

RESULTS WITH WINTER WHEAT

When the experiments with rotations and cultural methods were planned in 1913, it was impossible to determine from the information available whether spring wheat or winter wheat should be given the greater attention. The results show clearly the low value of winter wheat under the methods of cultivation generally practiced. It has been necessary to reseed all or most plats in 7 years out of 10. The stand of winter wheat has been lost by winterkilling and by soil blowing. Soil blowing is perhaps the more important factor of the two. Winds are high in winter and spring and when the surface of the ground is bare and dry cause more or less soil movement. Even a limited movement exposes the crowns and roots and breaks the surfaces of the leaves. The plants are unable to survive the damage and the heavy spring freezes incident to the altitude.

The annual and average yields of winter wheat, including reseedings to spring wheat, on the several preparations under trial are given in Table 3 and the averages shown graphically in Figure 3. The average yield of all plats was 10.2 bushels, a fraction of a bushel less than the corresponding average with spring wheat. The yield following peas as green manure was higher than that following rye as green manure. The yield on fallow was practically the same as the yield following peas plowed under and was only 0.3 bushel more than the yield of spring wheat on fallow. Disked corn ground averaged 11 bushels per acre. Late fall plowing, early fall plowing, subsoiling, and listing were all under trial on land continuously cropped to winter wheat. The average acre yields of these four methods ranged from 7.4 bushels on both late fall plowing and on subsoiling to 8.3 bushels on early fall plowing.

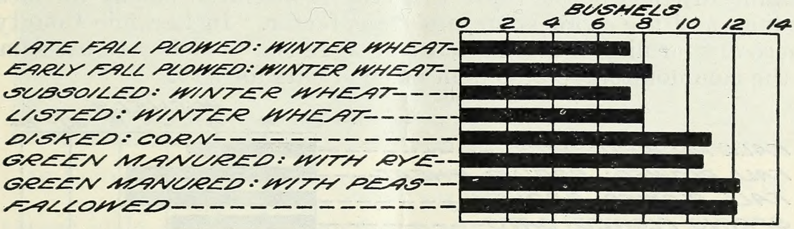

FIG. 3.—Average acre yields of winter wheat, including reseedings to spring wheat, grown by different methods at the Archer Field Station for the 10 years from 1914 to 1923, inclusive

TABLE 3.—*Yields of winter wheat grown by different methods at the Archer Field Station from 1914 to 1923, inclusive*

[Includes reseedings to spring wheat]

Treatment and previous crop	Plats averaged	Yields per acre (bushels)										
		1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	Average, 1914 to 1923
Late fall plowed:												
Winter wheat	1	3.9	25.9	4.3	13.8	2.8	1.0	4.5	10.7	0.4	7.0	7.4
Early fall plowed:												
Winter wheat	1	4.9	24.7	7.4	14.7	2.3	1.4	5.0	12.1	1.5	9.3	8.3
Subsoiled: Winter wheat	1	5.7	24.2	2.4	13.6	2.0	1.9	4.3	9.3	2.7	7.8	7.4
Listed: Winter wheat	1	4.0	21.2	5.4	13.7	1.9	1.9	7.7	10.9	5.0	8.3	8.0
Stubbled: Oats	2	------	------	------	10.0	22.5	0	6.9	10.8	0	9.5	------
Disked: Corn	3	4.8	27.1	4.2	12.6	17.1	1.7	3.1	24.7	.8	14.2	11.0
Green manured:												
With rye	1	4.8	25.3	4.3	18.0	9.0	1.9	4.0	24.3	3.1	11.7	10.6
With peas	1	6.1	29.7	7.5	17.0	28.5	.8	3.5	17.5	2.0	9.2	12.2
Total or average	2	5.5	27.5	5.9	17.5	18.8	1.4	3.8	20.9	2.6	10.5	11.4
Fallowed	3	7.7	26.4	6.2	15.6	20.3	1.8	4.0	24.3	5.4	9.2	12.1
Average of all 14 plats[1]	------	5.6	26.0	5.2	14.0	14.5	1.4	4.6	18.1	2.4	10.2	10.2

[1] Number not complete until 1917.

Results on two plats in 3-year rotations in which winter wheat is sown on disked oat stubble are available for the seven years from 1917 to 1923, inclusive. During this period the wheat sown on the unplowed oat stubble averaged 8.5 bushels per acre, while that sown on early-plowed wheat stubble averaged 6.6 bushels per acre.

Recent results indicate that the use of the furrow drill may contribute materially to success with winter wheat in this region and that it may be possible to work out cultural methods by which the losses from soil blowing and winterkilling can be substantially reduced.

RESULTS WITH OATS

The area devoted to oats in Wyoming in 1923 was 175,000[3] acres. This acreage is about the same as that of spring wheat. In the dry-farming districts of the State this crop is produced chiefly for local feeding, and the straw is an important factor. In Laramie County, where dry farming is most extensive, there is a tendency to use some of the common forage millets in place of oats for hay.

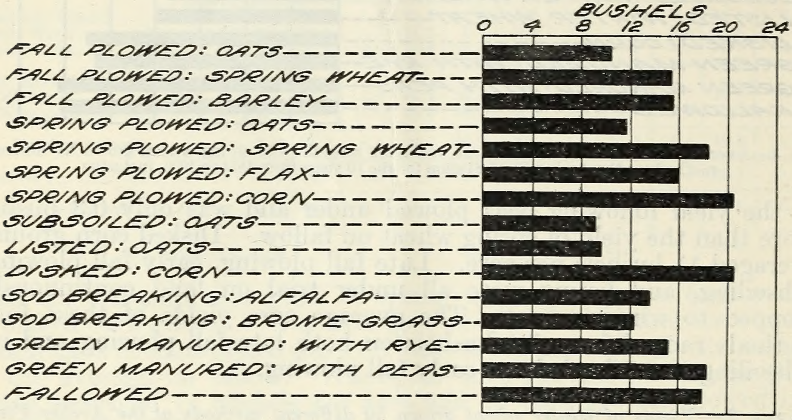

FIG. 4.—Average acre yields of oats grown by different methods at the Archer Field Station for the 10 years from 1914 to 1923, inclusive. The average following flax, spring plowed, is for the 9 years from 1915 to 1923, inclusive

The annual and average yields of oats by different rotation and tillage methods at the Archer Field Station for the 10 years from 1914 to 1923, inclusive, are given in Table 4, and the average yields are shown graphically in Figure 4. The 10-year average yield was only 16.9 bushels per acre. In 1915, 1917, and 1918 the yields from nearly all methods were good; in 1914, 1920, 1921, and 1923 fair yields were produced by some methods, but the averages were low; and in the other three years, 1916, 1919, and 1922, the crop was either very poor or failed entirely.

The highest average yields of oats were produced following corn. Nine plats on disked corn ground averaged 20.3 bushels for the 10 years under study. Exactly the same average yield was produced by three plats on spring plowing following corn. The superior behavior of oats on corn ground emphasizes the place corn occupies in the production of small grains. A plat of oats on disked corn ground in 1923 is shown in Figure 5. The yield of this plat was 26.6

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[3] U. S. Department of Agriculture. Statistics of important crops by States, 1921-1923. Oats. *In* Weather, Crops, and Markets, v. 4, p. 673. 1923.

bushels per acre. Green manures do not rank as high as preparation for oats as they do for wheat, but the relative positions of peas and rye as green manures are the same. The average yield of two plats following peas plowed under was 18.4 bushels, and the average yield of two plats following rye plowed under was 3.2 bushels less. The average yield of five plats on fallow was 18 bushels per acre, about the same as that following peas as green manure. One plat on spring plowing following wheat in a 3-year rotation in which the other crop was corn averaged 18.2 bushels per acre.

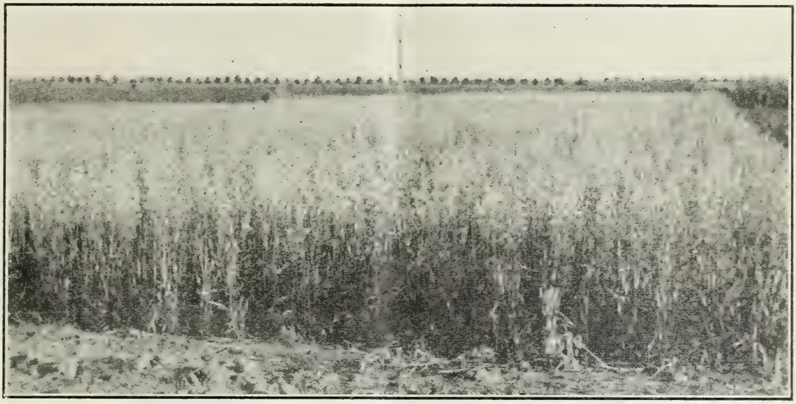

FIG. 5.—Oats on disked corn ground at the Archer Field Station in 1923; yield, 26.6 bushels per acre. Compare with Figure 9

TABLE 4.—*Yields of oats grown by different methods at the Archer Field Station, from 1914 to 1923, inclusive*

Treatment and previous crop	Plats averaged	Yields per acre (bushels)										
		1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	Average, 1914 to 1923
Fall plowed:												
Oats	1	14.5	35.9	3.8	23.4	18.1	0	2.8	2.2	0	2.8	10.4
Spring wheat	4	10.6	41.4	3.8	29.1	31.1	.7	14.9	3.8	.9	15.5	15.2
Barley	1	10.1	37.5	3.0	31.4	34.8	0	12.2	7.5	.9	16.3	15.4
Corn	1	------	------	------	25.3	35.6	.6	------	9.1	.6	20.0	------
Total or average	7	11.2	39.8	3.7	28.0	30.4	.5	12.4	4.8	.7	14.4	14.6
Spring plowed:												
Oats	1	15.0	33.8	3.9	25.8	25.6	.2	3.8	2.8	0	8.1	11.9
Spring wheat	1	23.4	44.1	2.8	34.5	27.7	1.6	16.9	16.6	1.3	13.4	18.2
Flax	1	------	42.5	7.7	21.4	36.6	.7	5.9	13.1	.9	15.6	[1] 16.0
Corn	[2] 3	23.6	46.0	5.8	27.4	46.9	2.3	14.3	15.5	1.6	19.2	20.3
Total or average	6	21.4	42.5	5.2	27.3	38.4	1.6	11.0	13.2	1.2	15.8	17.8
Subsoiled: Oats	1	9.4	34.7	5.6	22.0	14.2	0	1.7	2.2	0	3.4	9.3
Listed: Oats	1	13.0	32.8	2.0	22.7	12.8	.2	3.4	4.7	0	3.1	9.5
Disked: Corn	9	18.9	41.5	9.3	31.9	39.0	1.9	18.7	18.1	3.2	20.5	20.3
Sod breaking:												
Alfalfa	1	11.9	41.6	1.9	27.3	18.4	.9	12.8	15.0	.3	4.7	13.5
Bromegrass	1	10.5	42.2	2.5	23.3	24.7	1.1	10.0	.2	.9	8.8	12.4
Total or average	2	11.2	41.9	2.2	25.3	21.6	1.0	11.4	7.6	.6	6.8	13.0
Green manured:												
With rye	2	11.0	34.5	6.3	31.3	18.1	.7	15.5	20.1	.7	14.1	15.2
With peas	2	19.8	38.6	12.2	29.6	38.9	.6	16.1	13.9	1.3	13.0	18.4
Total or average	4	15.4	36.6	9.2	30.4	28.5	.6	15.8	17.0	1.0	13.5	16.8
Fallowed	5	20.0	36.8	6.7	28.5	34.1	2.1	12.0	13.7	2.9	22.7	18.0
Average of all 35[3] plats	------	16.5	39.6	6.5	28.8	32.8	1.3	13.6	12.4	1.7	16.2	16.9

[1] 9-year average.

[2] Only 2 plats on spring-plowed corn in 1914, 1915, 1916, and 1920.

[3] Number not complete until 1917.

The lowest yields were from land cropped continuously to oats. One plat was subsoiled and averaged 9.3 bushels, one was listed and averaged 9.5 bushels, one was fall plowed and averaged 10.4 bushels, and one was spring plowed and averaged 11.9 bushels per acre. The subsoiled plat in 1923 is shown in Figure 6. Compare the growth on this plat, which is representative of those continuously cropped to oats, with the much heavier growth following corn shown in Figure 5.

Spring plowing is generally superior to fall plowing as a preparation for oats.

The 10-year average yield on alfalfa sod was 13.5 bushels and on brome-grass sod 12.4 bushels per acre.

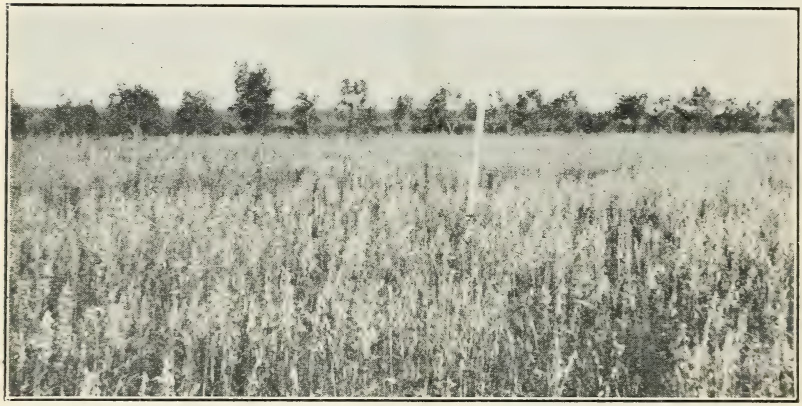

FIG. 6.—Oats at the Archer Field Station in 1923 on land subsoiled and continuously cropped to oats; yield, 3.4 bushels per acre. Compare with Figure 5

RESULTS WITH BARLEY

The acreage of barley in Wyoming is small, but there is continued and increasing interest in the crop. The rotation and cultural experiments contain but eight plats of barley. The annual and average yields of these plats are given in Table 5. Six of the plats were started a year later than the other work, and averages are computed for the nine years from 1915 to 1923, inclusive. The average yields for this period are shown graphically in Figure 7. These averages are comparable with the 10-year averages of other crops, as the yield of barley in 1914 was very nearly normal.

The average yield of the eight plats for nine years was only 12.6 bushels per acre. The heaviest yielding method under trial was summer fallow, on which the yield averaged 18.6 bushels per acre. The next highest yield, 15.1 bushels, was on disked corn ground. A plat on spring plowing following oats in a 3-year rotation averaged 14.2 bushels per acre. The lowest yields were on the four plats cropped continuously to barley. The spring-plowed plat in this series averaged 12.3 bushels, the listed plat 10.3 bushels, the fall-plowed plat 9.3 bushels, and the subsoiled plat 9.1 bushels per acre. With barley, as with other crops, spring plowing yielded higher than fall plowing, and no advantage was gained by subsoiling.

TABLE 5.—*Yields of barley grown by different methods at the Archer Field Station from 1914 to 1923, inclusive*

Treatment and previous crop	Plats averaged	Yields per acre (bushels)										
		1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	Average, 1915 to 1923
Fall plowed:												
Barley	1	------	29.8	5.2	10.8	23.4	0.3	1.5	7.3	2.5	2.9	9.3
Spring plowed:												
Barley	1	------	31.3	6.5	12.7	38.6	1.1	1.4	10.4	3.2	5.8	12.3
Oats	1	12.5	35.6	[1] 7.3	19.0	30.4	5.1	4.3	15.6	1.5	9.2	14.2
Total or average	2	------	33.5	6.9	15.9	34.5	3.1	2.9	13.0	2.4	7.5	13.3
Subsoiled: Barley	1	------	35.8	4.2	13.3	7.3	0	6.5	8.5	2.0	4.6	9.1
Listed: Barley	1	------	30.6	1.8	11.5	22.7	.2	9.4	9.6	2.1	5.0	10.3
Disked: Corn	1	10.4	30.2	12.9	17.9	32.5	5.0	5.9	17.3	4.4	10.2	15.1
Disked: Flax	1	------	30.4	6.6	9.0	30.6	2.0	6.7	11.7	5.1	4.6	11.9
Fallowed	1	[2] 15.8	31.0	13.8	14.8	44.4	5.7	7.7	19.6	9.8	20.6	18.6
Average of all 8 plats	------	------	31.8	7.3	13.6	28.7	2.4	5.4	12.5	3.8	7.9	12.6

[1] Interpolated yield. [2] Six plats on prairie sod broken in May, 1913, and fallowed during the summer.

RESULTS WITH FLAX

The experiments with flax have been comparatively extensive. Flax has been grown under a wide range of cultural methods and following the more important crops. The continuously cropped plats, including the one alternating with fallow, were discontinued in 1923. The results are given in Table 6 and show that none of the methods under trial have given satisfactory results. The highest average yield for the nine years from 1915 to 1923, inclusive, was 3.8 bushels on disked corn ground. The next highest yields were 3.6 bushels on spring-plowed wheat stubble and 3.3 bushels on spring-plowed corn ground. Such yields do not make flax a serious competitor of other crops.

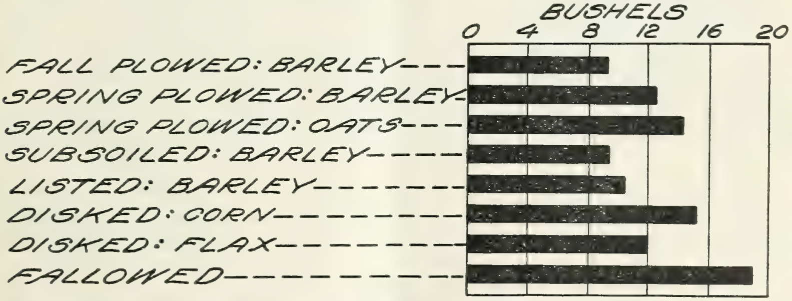

FIG 7.—Average acre yields of barley grown by different methods at the Archer Field Station for the nine years from 1915 to 1923, inclusive

Flax was grown in these experiments only on old land. The chief difficulty with flax under this condition is its inability to compete with weeds, particularly with the Russianthistle. On one plat it was grown in intertilled strips. Using the grain drill three rows were sown and three left blank for cultivation. The weeds within the rows remained as much of a problem as in the ordinary sowings. The results of some experiments in 1923 indicate the possibility of reducing weed growth by the use of a deep-running cultivator, such as the duck-foot, before seeding. The control of weeds in the early stages of growth seems to be one of the principal factors upon which the successful production of flax depends.

Flax is ordinarily grown as a sod crop, but it has not been tried on sod in these experiments. Farm experience with flax on prairie sod on the whole has been unsatisfactory in this region. The trouble on sod is the lack of sufficient water rather than the competition of weeds. The native grasses keep the water in the soil reduced to a small quantity. Breaking is generally late, there is little water already in the soil, and the precipitation during the season after breaking is not sufficient to meet the needs of the crop. The chances of success are greatly enhanced when the breaking is done early, so that the spring precipitation is conserved.

TABLE 6.—*Yields of flax grown by different methods at the Archer Field Station from 1914 to 1923, inclusive*

Treatment and previous crop	Plats averaged	Yields per acre (bushels)										
		1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	Average, 1915 to 1923
Fall plowed:												
Corn	1	------	11.1	0	7.2	2.4	0	0	1.9	0.9	1.6	2.8
Flax	1	4.5	12.7	0	3.6	.9	0	0	.8	0	------	------
Total or average	2	4.5	11.9	0	5.4	1.7	0	0	1.4	.5	1.6	[1] 2.7
Spring plowed:												
Corn	2	------	11.3	0	8.0	3.7	0	0	3.4	.5	2.8	3.3
Oats	1	------	15.4	0	9.3	1.7	0	0	2.7	0	0	3.2
Wheat	1	------	15.0	0	8.6	4.2	0	0	4.6	0	0	3.6
Flax	1	4.4	11.1	0	7.1	2.3	0	0	.6	0	------	------
Flax [2]	1	------	8.6	1.8	3.7	.9	0	0	1.3	.2	------	------
Total or average	6	4.4	12.1	.3	7.5	2.8	0	0	2.7	.2	1.4	[1] 3.1
Disked: Corn	2	------	11.9	0	10.1	5.7	0	0	4.1	.4	2.2	3.8
Subsoiled: Flax	1	3.0	12.0	0	3.4	.4	0	0	.2	.2	------	------
Listed: Flax	1	3.3	8.6	0	0	.4	0	0	.4	0	------	------
Fallowed	1	6.3	13.9	0	8.0	1.1	0	0	1.7	1.6	------	------
Average of all 13 plats [3]	------	4.3	11.9	.1	6.7	2.5	0	0	2.2	.3	1.6	[1] 3.0

[1] 10-year averages, 1914 to 1923, inclusive. [2] In 3-row strips, intertilled. [3] Only 5 plats in 1914 and 7 in 1923.

RESULTS WITH CORN

The corn acreage in Wyoming increased from 11,000 acres in 1910 [4] to 150,000 acres in 1923.[5] During the later years the increase was very marked. A definite method of culture has not yet been developed. It is beginning to be recognized that corn is relatively a safe crop and that small grains sown upon disked corn ground produce well. The experimental data already presented show that for the most economical production small grains must be seeded upon disked cornland. The vital question to agriculture in this region, then, is the economical production of corn. In the consideration of this subject it must be remembered that, although the grain yields are of great importance, the stover yields should be given more consideration than in sections where the production of forage is not so important. In order to make profitable use of the corn crop and of the lands not suited to tillage, livestock is necessary to farm operations. The closeness of the dry farms to the ranges is an asset of which advantage will no doubt be taken in the future.

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[4] U. S. Department of Agriculture. Bureau of Statistics. Statistics of the principal crops. *In* U. S. Dept. Agr. Yearbook, 1912, p. 560. 1913.

[5] ——— Statistics of important crops by States, 1921–1923. Corn. *In* Weather, Crops, and Markets, v. 4, p. 670. 1923.

The annual and average yields of corn by different methods are given in Table 7 and the averages shown graphically in Figure 8. Spring plowing produced higher yields than fall plowing. Spring-plowed barley stubble produced the highest 10-year average yield, 19 bushels per acre. Spring-plowed spring-wheat land produced an average of 17.4 bushels per acre. Contrary to the results from continuous cropping with the small grains, corn produced rather high yields on plats continuously cropped to corn except on the listed plat. Subsoiling produced an average acre yield of 17 bushels of corn, listing 11.4 bushels, and summer fallow 17.2 bushels. Spring-plowed corn stubble produced an average yield of 16 bushels. This is 0.8 bushel less than the average of all spring-plowed plats. Continuous corn on fall plowing produced an average yield of 14.7 bushels per acre, or 1 bushel more than the average of all fall-plowed plats. Farmers report good results by listing wheat stubble, but listed corn is generally a little later and smaller than surface-planted corn. Where the seasons are short and it is desired to cut the crop with a binder, these factors may become decisive.

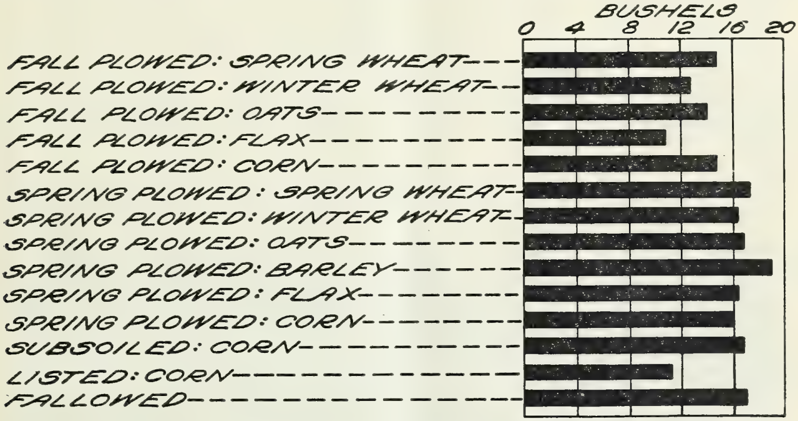

FIG. 8.—Average acre yields of corn grown by different methods at the Archer Field Station for the 10 years from 1914 to 1923, inclusive. The averages following winter wheat, fall plowed, flax, fall plowed, and flax, spring plowed, are for the 9 years from 1915 to 1923, inclusive

The yields of stover follow fairly closely the same order as those of grain, averaging 114 pounds to 1 bushel of grain, equal to about 1,800 pounds per acre.

During the years 1913 to 1915 Brown County Yellow Dent corn was grown on these plats. It was found to be rather late in maturing and was replaced by Northwestern Dent in 1916. In 1919 Swadley Yellow Dent from the Akron (Colo.) Field Station was introduced into this experiment and was used during 1919 and 1920. This corn is somewhat later than Northwestern Dent, and the ear is placed higher on the stalk. It was found necessary to revert to Northwestern Dent, which has proved to be one of the best varieties for this district. Later varieties produce more stover but less grain. Careful attention should be given to the selection of a variety and strain of corn adapted to the local conditions.

TABLE 7.—*Average yields of corn grown by different methods at the Archer Field Station from 1914 to 1923, inclusive*

Treatment and previous crop	Plats averaged	Yields per acre (bushels)										
		1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	Average, 1914 to 1923
Fall plowed:												
Spring wheat	2	12.2	0	13.9	16.3	31.9	7.5	7.9	9.1	17.0	32.7	14.9
Winter wheat	[1] 2	------	0	6.9	21.3	29.6	1.8	4.0	1.4	11.4	39.0	[2] 12.8
Oats	4	11.9	0	11.2	19.6	27.1	4.4	4.8	8.1	15.0	36.9	13.9
Flax	1	------	0	6.9	19.8	25.4	0	2.4	3.6	7.3	32.4	[2] 10.9
Corn	1	20.8	0	15.4	18.0	15.0	7.5	3.9	18.5	14.1	33.7	14.7
Total or average	10	13.3	0	11.3	19.1	27.2	4.3	4.9	7.5	13.8	35.7	13.7
Spring plowed:												
Spring wheat	5	13.1	0	23.0	19.5	34.1	5.6	6.7	15.2	18.9	37.8	17.4
Winter wheat	[3] 4	12.7	0	22.5	26.6	33.9	5.1	3.7	10.9	15.5	33.9	16.4
Oats	11	12.5	0	22.8	21.8	35.7	5.2	4.2	13.7	14.4	37.3	16.8
Barley	1	18.0	0	25.4	20.4	28.4	9.6	6.8	15.6	17.9	48.0	19.0
Flax	3	------	0	24.3	22.3	35.8	3.2	5.7	10.0	14.7	32.5	[2] 16.5
Corn	1	19.7	0	22.3	21.8	14.1	11.7	4.0	21.1	12.4	32.9	16.0
Total or average	25	13.3	0	23.1	22.1	33.9	5.4	4.9	13.5	15.5	36.5	16.8
Subsoiled: Corn	1	22.0	0	[4] 18.8	26.3	11.9	20.0	2.2	21.4	15.7	32.0	17.0
Listed: Corn	1	19.1	0	[4] 13.1	11.3	3.5	17.5	4.4	14.0	13.1	18.0	11.4
Fallowed	1	20.0	0	29.8	22.1	14.3	12.4	5.8	16.0	18.8	32.6	17.2
Average of all 38 plats	------	14.0	0	19.9	21.1	30.2	6.0	4.8	12.2	15.1	35.6	15.9

[1] Only one plat on fall-plowed winter wheat in 1916.
[2] 9-year averages.
[3] Only three plats on spring-plowed winter wheat in 1916.
[4] Interpolated yields.

GENERAL DISCUSSION OF ROTATIONS

The experimental field was in native sod until 1912, and the first crops were grown on it in 1913. The soil is characterized by the fertility common to most semiarid and arid soils. It is evident that no changes in production due to changes in fertility are to be expected in so short a time. If the different cropping systems are working toward such changes by reducing, maintaining, or increasing fertility, such effects are for the present masked by the already adequate supply of fertility and by the controlling influence of the inadequate supply of water.

None of the plats to which barnyard manure has been applied have shown any increase in yield over those which do not receive manure. Plowing peas under for green manure has resulted in increasing the yields of the following crops of spring wheat, winter wheat, and oats over those on bare fallow. There are no soil-moisture determinations at this station from which to compare the relative water contents of the soil following these two preparations, but such comparisons at other stations and a consideration of the conditions of the two warrant the belief that the increased yield is not to be explained by an increased water supply. The beneficial effect, however, is exhausted in the one crop that immediately follows the peas and is not evidenced in other crops in the rotations or in a cumulative effect in succeeding rounds of the rotations.

It is evident from the results that have been presented that, in determining what crop to sow, attention should be given to the crop that was last grown as well as to the preparation of the seed bed. The results show that up to the present time the crops have been little affected by the cropping or treatment further removed than one year. This leads to the conclusion that practically the full effect of rotation is realized in rotations only two years in length. It may, however, be necessary in planning the cropping system to make longer combinations than this. It is generally a good practice to have a fairly definite plan of cropping arranged, so as to distribute labor in such a manner that as many acres as possible can be handled with a given unit of men, teams, and machinery. The production of corn on a portion of the farm accomplishes this to a large extent.

CROP RESISTANCE TO DROUGHT, DISEASE, AND STORM

The success of farm operations often depends upon the resistance of crops to adverse conditions, such as drought, disease, and severe storms. For these reasons the spring wheat most commonly grown in the immediate vicinity of the station is durum. The results of recent years have emphasized the necessity of rust-resistant cereals. Kota is recommended for a spring common wheat and Kanred for a winter variety. Figure 9 shows the variety-test plats of Kota and Converse wheat in 1923. Note how the latter had fallen from the effects of black stem rust, whereas the former was little affected. Acme is the highest yielding rust-resistant durum wheat, but it does not produce macaroni of satisfactory quality. Peliss has been found well adapted to the higher altitudes in Wyoming, yielding nearly as well as Acme.[6] Corn by its manner of growth and culture generally evades the drought. Severe hailstorms sometimes injure it greatly,

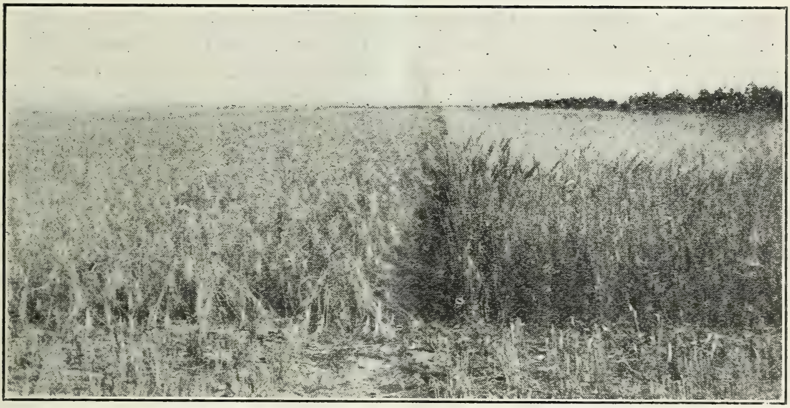

FIG. 9.—Kota spring wheat (at right) and Converse spring wheat (at left) at the Archer Field Station. Converse was nearly destroyed by black stem rust, but Kota was little affected. Photographed September 15, 1923

but it is generally able to recover in a large measure and to produce a fair yield of forage when other crops succumb. An early variety of corn is recommended on account of the short season. Northwestern Dent is the variety mainly grown at the experiment station.

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[6] Clark, J. A., Martin, J. H., and Smith, R. W. Varietal experiments with spring wheat on the northern Great Plains. U. S. Dept. Agr. Bul. 878, 47 p., illus. 1920.

Notwithstanding the fact that oats are subject to injury from drought and hail, they are very extensively grown. In the varietal experiment the highest 9-year average yield of grain, 31.1 bushels per acre, was produced by Kherson. The average yield of straw of this variety was 1,845 pounds per acre. The largest average total yield was produced by Ligowa. The acre yield of this variety was 30.8 bushels of grain and 2,217 pounds of straw.

Barley has not been injured by hail and drought so severely as oats. The straw of the early varieties is short, the same as with oats. White Smyrna is recommended for an early variety and Horn for a late variety. The average acre yields for the 4-year period from 1918 to 1921, inclusive, were 28.3 bushels from White Smyrna and 30.1 bushels from Horn. Both are two-rowed bearded varieties, but the beards are not so heavy or persistent as they are on Coast, a commonly grown variety.

DATES AND RATES OF SEEDING

During the seven years from 1913 to 1919, inclusive, experiments were conducted in cooperation with the Office of Cereal Investigations of the Bureau of Plant Industry to determine the best dates and rates of seeding the several spring-sown small grains. Similar experiments were conducted with winter wheat for the four years from 1918 to 1921, inclusive. A common wheat, Ladoga, sometimes known as Spring Turkey, was used in the date-of-seeding experiments with spring wheat. The highest average yield for the seven years from 1913 to 1919, inclusive, was 12.9 bushels per acre from seeding on May 1. The April 15 seeding averaged 10.9 bushels and the May 15 seeding 10.7 bushels. Seeding as late as June 1 and June 15 resulted in a marked falling off in yields. The growing and fruiting periods of such late seedings are extended into the drier part of the season and maturity is hastened by drought.

A durum wheat, Arnautka (C. I. No. 1493), was used in the rate-of-seeding experiment with spring wheat. The yield of wheat is not influenced so much by the rate of seeding, within a considerable range, as it is by the date of seeding. The average acre yields for the seven years from 1913 to 1919, inclusive, from seeding at the rates of 2, 3, 4, 5, and 6 pecks per acre were 15.1, 15.7, 16.2, 15.9, and 15.7 bushels, respectively. Stands were rather thin and weedy from the sowings made at the rate of 2 pecks, and the yields were slightly decreased from rates of seeding heavier than 4 pecks. The results show the best rates of seeding to be from 3 to 4 pecks per acre.

Experiments on the date of seeding oats were conducted with Swedish Select, a midseason variety, and Kherson, an early variety. The experiments with Swedish Select covered only the three years from 1917 to 1919, inclusive. During these three years the average acre yields from the different dates of seeding were May 1, 29.2 bushels; May 15, 33.5 bushels; and June 1, 23.2 bushels. The experiments with Kherson covered the seven years from 1913 to 1919, inclusive. The average acre yields from the different dates of seeding were May 1, 30.6 bushels; May 15, 29 bushels; and June 1, 26 bushels. With both varieties there was a sharp decrease in yield from sowing as late as June 1, but little choice as to the time of seeding before the middle of May.

Kherson oats were sown at the rates of 3, 4, 5, 6, and 7 pecks per acre in each of the five years from 1914 to 1918, inclusive. The 5-year average yields from each of these rates were 33.3, 36.6, 39.3, 40.6, and 38.4 bushels per acre, respectively. These results indicate the best rate of seeding to be from 5 to 6 pecks per acre.

A 2-rowed barley, Svanhals (C. I. No. 187), was used in an experiment on the date of seeding barley which was conducted for the seven years from 1913 to 1919, inclusive. The dates of seeding were April 15, May 1, and May 15, except in 1918, when there was no seeding on April 15. The 7-year average yields for the May 1 and May 15 dates of seeding were 18.8 and 20.4 bushels per acre. Excluding 1918 the 6-year average acre yields from each of the three dates of seeding were April 15, 15.1 bushels; May 1, 15.4 bushels; and May 15, 15.7 bushels. It is evident that the best time to sow barley is during the first half of May. The ill effect of late seeding was shown in 1920 when Coast barley sown on disked corn ground in the varietal tests on May 22 yielded 20.8 bushels per acre and sown on the same preparation in the rotation experiments on June 14 yielded only 5.9 bushels.

Rate-of-seeding tests were conducted with Svanhals barley for the seven years from 1913 to 1919, inclusive. The average yields from seeding at the rates of 2, 3, 4, and 5 pecks were 19.9, 22.2, 23.7, and 22.9 bushels per acre, respectively. It is evident that about 4 pecks per acre is as much seed as is necessary.

The results of seeding flax at different dates depends more upon the cleanness of the seed bed from weeds than it does upon the date itself, provided the date is early enough to allow the crop to mature. In the date-of-seeding experiments the practice was to double-disk the land to be seeded to flax the day before seeding. This gave the late seedings the cleaner seed beds, as the weeds in them had germinated and were destroyed before seeding. The experiments were conducted both on disked corn ground and on fallow. The better yields were on disked corn ground. The average acre yields for seedings on April 15, May 1, May 15, and June 1 were 4.8, 6.6, 7.5, and 8.2 bushels, respectively. In 1918 a seeding made on June 15 yielded 8.4 bushels per acre. A seeding as late as this usually would not mature.

The 5-year average yields of flax sown at the rates of 10, 15, 20, and 25 pounds per acre were 8.9, 9.6, 9.7, and 9.5 bushels per acre, respectively. The 10-pound rate appears to be too light, but the differences between the other rates did not materially affect the yields. The variety used in both the date-of-seeding and the rate-of-seeding experiments was Russian (C. I. No. 19).

The problems in the dates of seeding and rates of seeding of winter wheat are peculiar to winter cereals. The chief difficulty in the production of winter wheat is soil blowing. The effect of the date of seeding on this factor is very important. If a good growth is produced before cold weather, the crop is certain to pass the winter in good condition unless it is damaged by soil blowing, and the better the growth the better it will resist soil blowing. The dates upon which this crop was seeded were August 15, September 1 and 15, October 1 and 15, and November 1. The average yields for the four years from 1918 to 1921, inclusive, for these dates were 18.9, 20.4, 16.8, 10.2, 7.9, and 9.9 bushels per acre, respectively. It is obvious that September 1 is the preferable date of seeding. Seedings on disked oat stubble can be made earlier than this with profit, but on fallow there is likely to be some winterkilling from earlier seeding. Seedings of October 1 are seldom any better than seedings of a later date. It has been found that 3 pecks is sufficient seed on fallow, whereas 4 to 5 pecks is preferable on disked oat stubble.

Figure 10 shows the crop of winter wheat on fallow seeded September 1, 1920. The plat to the left was seeded August 15 and the one to the right on September 15.

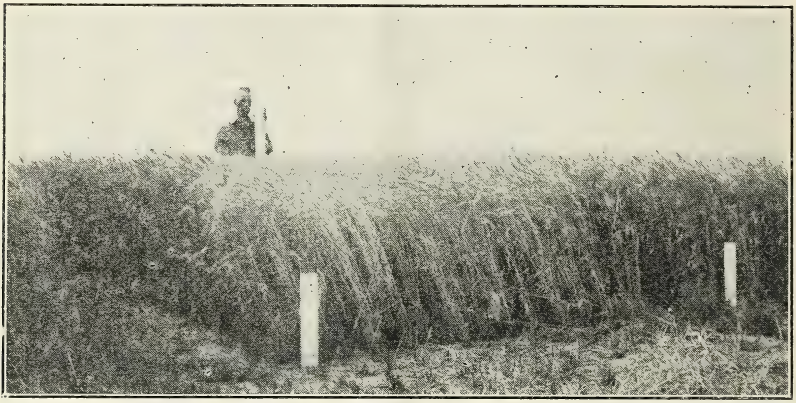

FIG. 10.—Winter wheat on fallow in 1921 at the Archer Field Station. Seeding of September 1, 1920, in center, seeding of August 15 at left, and that of September 15 at right

SUMMARY

The Archer Field Station is located near Cheyenne in southeastern Wyoming. The altitude is about 6,000 feet. The soil is typical of the upland soil of the region. The results of experiments in methods of crop production begin in 1913 and are reported to and including the year 1923.

The average annual precipitation at the station for the 11 years from 1913 to 1923, inclusive, was 15.01 inches. The average annual precipitation recorded by the United States Weather Bureau at Cheyenne for the same period was 15.51 inches, and for the 53 years from 1871 to 1923 it was 14.17 inches.

The average acre yield of spring wheat from all plats for the 10 years from 1914 to 1923 was 10.9 bushels. The highest average yield, 13.3 bushels, was following peas plowed under for green manure; but this method is too expensive to make it relatively profitable in comparison with fallow or with disked corn ground, on both of which the yields averaged 11.8 bushels to the acre. The yields following small grains averaged from 7.4 to 9.3 bushels to the acre.

Winter wheat is not a reliable crop. It was necessary to reseed all or most plats 7 years out of 10. The losses were due to winterkilling and soil blowing. It may be possible to develop cultural methods that will reduce substantially the losses from these causes.

The 10-year average yield of oats from all plats was 16.9 bushels to the acre. The highest average acre yields were obtained following corn, both disked and spring-plowed corn ground averaging 20.3 bushels. The lowest yields were from plats cropped continuously to oats. The average yields of these plats were less than 12 bushels to the acre.

The average acre yield of barley was 12.6 bushels. The highest yield, 18.6 bushels, was on fallow. The next highest yield, 15.1 bushels, was on disked corn ground. Plats cropped continuously to barley averaged from 9.1 to 12.3 bushels to the acre.

Flax did not produce satisfactory average yields, largely on account of its inability to compete with weeds, particularly with the Russian-thistle.

Corn proved a fairly reliable crop for both grain and forage. The use of an early variety is essential to the production of grain. The average yield of all plats was 15.9 bushels of grain and about 1,800 pounds of stover to the acre. The average yield of corn was not as high on fallow as it was when grown by several other methods. Contrary to the results with small grains, continuous cropping to corn except on the listed plat produced relatively good yields. The yield of stover averaged 114 pounds to the bushel of grain.

Yields of all crops were generally better on spring plowing than on fall plowing.

Subsoiling did not prove an advantageous or profitable operation.

Experiments on rate of seeding indicate the desirability of seeding at the following rates to the acre: Spring wheat, 3 to 4 pecks; winter wheat, 3 pecks on fallow and from 4 to 5 pecks on stubble; oats, 5 to 6 pecks; barley, 4 pecks; and flax, 15 to 25 pounds.

Experiments on date of seeding show that spring grains should not be sown later than the middle of May and winter grains about September 1.

The choice of crops and varieties that evade or resist drought, storms, and diseases may contribute much to success.

The danger of complete loss in any season may be greatly minimized by dividing the acreage between crops that make their principal growth in different parts of the season and mature at different times. This may be accomplished by the use of spring grains, winter grains, corn, and such crops as millet and Sudan grass.

The production of corn is essential to the most economical production of small grains. Corn provides feed for livestock, and if the full value of it is to be realized it is necessary that it be fed on the farm. The growth of corn thus makes possible the production of small grains and the maintenance of livestock. Such a combination decreases the hazards of both the livestock and the grain production and tends to the maintenance of a stable agricultural population.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

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